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HOME-MADE THUNDERBOLTS

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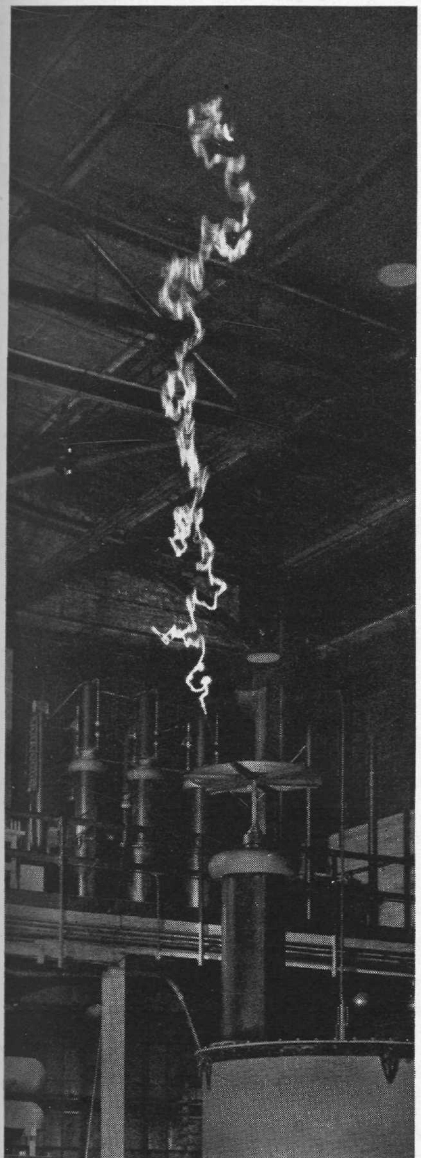

Courtesy U. S. Steel News.

A Large Scale Industrial Test Spark

With a crashing as of miniature thunderbolts, and with a pungent smell of ozone and a weird purple glow, long streamers of electricity leap from a ball mounted upon a coil into the surrounding air. There is a strange tension in the air, your skin prickles, and you can feel your hair standing on end. These are the effects produced by a large high-frequency coil in operation. Many fascinating experiments for pleasure and instruction may be performed with the aid of such a coil. As Frankenstein's monster is born, the electrical flickerings and sparks are made with apparatus of this type. High-frequency currents have an interesting property known as the "skin effect". The bulk of the current travels on the surface of a conductor or on your body so that the discharge of the high-frequency coil may be taken through the body with no serious effects. In fact, the passage through the body of many hundred-thousand volts can hardly be felt. Current of the standard frequency, 60 cycles per second, causes a muscular contraction called shock each time it changes direction. When the frequency of the current is increased to 10,000 cycles per second no shock is felt because the direction of the current is reversed so rapidly that the body cannot feel it. High-frequency currents range from 10,000 to several million cycles per second. When the operator of the coil holds a metal rod within sparking distance of the ball mounted on top of the coil, a spark will jump to the rod and the current will pass into his body. The voltage of the current is so great that after passing through his body it is still sufficient to light a lamp connected between him and an assistant. The performer may light a cigarette from the spark jumping between his finger and the body of his assistant. Neon tubes will light to their full brilliancy without a direct connection when brought within several feet of the coil. That a high-voltage is used in these experiments can hardly be doubted, after one has witnessed the magnificent halo surrounding the discharge ball of a large coil. Many other experiments may be performed with currents as high as 1,000,000 volts, if reasonable precautions are taken.

The two most commonly used oscillation transformers for high-frequency experimentation are the Tesla and Oudin coils. In this type of transformer the secondary coil is placed in a vertical position, and the primary coil is wound around its base and insulated by an air space between the two coils. This transformer has a connection between the primary coil and the secondary coil. The second type of oscillation transformer, the Tesla coil, is similar in construction; however it lacks the connection between the primary and secondary coils. The secondary coil of the Tesla transformer is usually placed in a horizontal position with the primary coil wound around the center of the secondary form. When a high-voltage, high-frequency current from the transformer and auxiliary equipment shown in the photograph is connected to the primary coil of an oscillation transformer, it causes a higher voltage current to be induced in the secondary coil, and sparks will jump from the rod mounted on the coil. This is called the "corona" of the coil, and these sparks may be several inches in length from a large coil. These coils are used to produce high-frequency current for electrical experiments and stage demonstrations.

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Coils of this type are built by winding small wire on a cylindrical form. For an Oudin coil 400-600 turns would give a short, fat spark. A Tesla coil would have 600-800 turns and would produce a longer, thinner spark of higher voltage, but lower amperage. Extraordinary precautions must be observed while winding to prevent short circuits. No nails may be used in constructing the form, and even paints with metallic pigments must be avoided. The primary coil may be made of copper tubing, copper strip, or heavy cable wound around a supporting frame. The Tesla primary must have a special support to insulate it from the secondary coil. Detailed plans for building coils will be found in several popular science magazines and books.

In order to furnish the high-voltage current for the coil, there must be auxiliary equipment consisting of a transformer, condenser, and spark gap. The transformer changes the 115-volt line current to 10,000-12,000 volts. A shock from this transformer would be very dangerous, not only because of the high voltage, but also because it is still 60 cycle current. This high-voltage, low-frequency current is fed into a condenser which gives it a higher frequency as the condenser charges and discharges across a spark gap thousands of times per second. The current from the spark gap is connected to the primary of the oscillation transformer, thus stepping up the voltage to several hundred thousand volts. The spark gap may be either rotary and turned by a small motor, or stationary. The use of the stationary gap is usually restricted to smaller outfits. There are other types of spark gaps, but they are expensive and difficult to construct.

High-frequency electricity has many uses. X-ray tubes are operated by current of this type. High-frequency, high-amperage currents of low voltage are used in short wave diathermy to treat "charley-horses" and to produce artificial fever. Plants of increased weight and food value may be grown in special plots where they may be exposed to the effect of high-frequency current. The cyclotron uses high-frequency current in its tank to give the particles a periodic "kick" as they travel around the "dees". Insulators which have been tested with a high-voltage spark can be depended upon to stand up under normal use. Some laboratories are studying artificial lightning bolts made in this manner in an effort to understand lightning better. Although the transmitting current used in radio stations is of a very high-frequency, it is controlled by vacuum tubes instead of spark gaps. The vacuum tubes produce current of standard frequency that can be easily regulated. These, then, are some of the practical uses of a fascinating hobby, high-frequency electricity.